THE MOST IMPORTANT FACTORS INFLUENCING QUALITY OF CONVEX PRINTOUTS FOR THE BLIND

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Abstract: People who have lost sight also loose the simplest ability of acquiring information about the surrounding world. Newspapers become unreadable, and writing a letter to a friend has to be done by a third person. Nevertheless, with the development of modern technologies, the number of new devices, which support the communication of blind people, is increasing (also microprocessor). Yet still Luis Braille's system, which uses point-convex signs, is most commonly used.

A new problem has arisen, namely modern convex printing technology is not always in proper relation to the quality of the printouts. There are no quality standards which precisely describe the parameters which have the biggest influence on the quality of convex copies, nor is it established how these parameters should be measured and which values should be allowed.

Introduction

The development of new hardware aiding blind and weak sighted people is observed together with the progress of new technologies, e.g. computers and electronic pocket notebooks are equipped with speech synthesisers. In spite of the current trends of artificial reading of Braille texts, traditional reading (developed in 1829) is still used. Braille's alphabet is read with the fingertips, from left to right (every finger covers one braille sign). both hands are used in the process of reading (the right hand analyses while the left hand synthesizes signs).

Independent of count of points, each braille sign occupies the same area. Braille's alphabet is based on an array of six points in the area of a rectangle. The points are numbered:

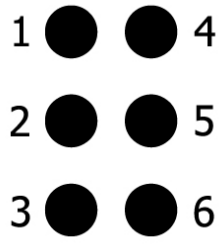

Figure 1: Braille's six-point

Using different combinations of points, it is possible to get 64 characters: 1 without points (space), 6 one-point, 15 two-point, 20 three-point, 15 four-point, 6 five-point and 1 six-point. Each sign in Braille's alphabet represents one letter in the standard alphabet. Capital letters consist of two signs - the sign for the capital letter and the sign of the letter itself. Digits are similarly made up of two signs – the sign for the digit and the first letters of alphabet). Most letters are the same in all languages. The remaining signs represent language specific letters.

Braille's alphabet is used in special hardware for the blind, e.g. the Braille writing machine, Braille monitors.. The alphabet is also used to publish. books, newspapers, magazines, didactic help and dictionaries.

There are several technologies of making printouts with convex text and graphics. Technology is one of the factors which influence the quality of the copy, and the parameters describing the quality.

Parameters

Quality parameters can be analysed in two aspects. The first is connected with the estimate of a single point in Braille character (e.g. height (h) and diameter (d) of a point – figure 2, roughness of the surface – figure 3).

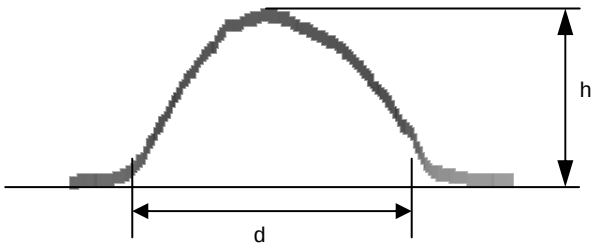

Figure 2: Height and diameter of a point

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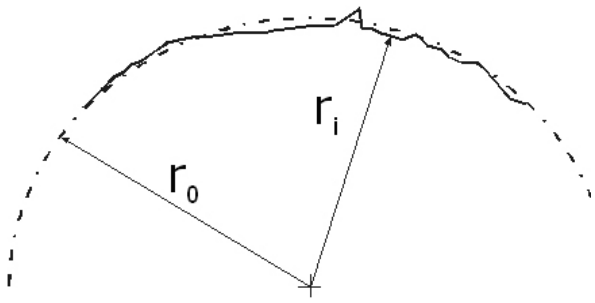

Figure 3: Roughness of the surface

Roughness of a point's surface is estimated with parameter R_B

$$R_B = \sqrt{\frac{\sum_{i=1}^{n}(r_i - r_0)^2}{n-1}} \qquad (1)$$

The second aspect is connected with many points, which form the text (e.g. the distance between points in a sign (a), between signs (z) and between lines (2a) – figure 4).

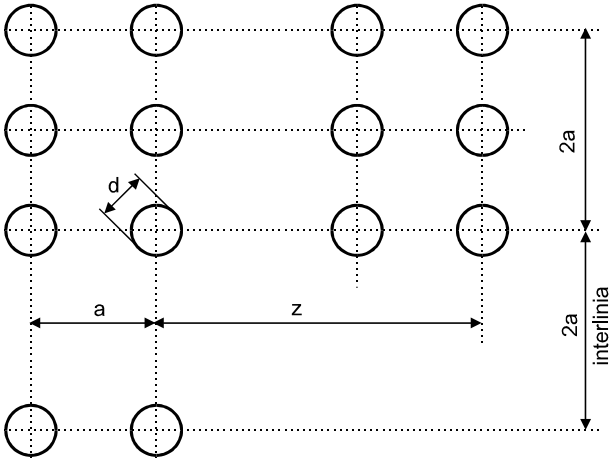

Figure 4: Parameters of braille text

Values of quality parameters of convex printouts are very different. They are greatly influenced by: the technology of making a printout, the construction of hardware, even the kind of.

The blind say that the most important factor which influences the quality of convex printouts is the height of the points (this parameter determines, whether the text can be read or not. Even a well-convexed printout (with the right geometric parameters) might be read unwillingly. because of excessive roughness of the copy's surface. This causes induration of fingertips and reducing tactile sensitivity.

The parameters describing the quality of convex printouts are not normalised, therefore such copies have very different quality. The best estimate of quality is the opinion of a blind person. But what is also important, is the correlation of this estimate with technically measurable parameters.

The estimation of the parameters' range would force producers to make good quality printouts.

Technologies of making convex copies

While the progress of mechatronic devices proceeds, older technologies of making convex printouts are modernized and brand new technologies of making convex text and convex graphics appear.

Below are a few most popular technologies:

- embossing points
- copying on microcapsule paper
- forming thermal foil
- spraying swell ink
- spraying layers of ink

The most propagated method is embossing points in paper (because of its mechanical durability paper of 200g/m^2 basic weight is used). Rounded pins are arranged in six-point Braille signs. The pins hit the paper (the paper is appressed with a rubber roller from the other side) and makes the paper embossed. Such printouts have low durability because the point's height is reduced while using and after about 30 tactile readings it is unreadable. Another disadvantage of this technology is the problem of printing graphics. There are many devices based on this technology. The simplest, hand-writing machines have low repeatability (varied force applied to buttons). The more complicated devices have a possibility of printing from a computer, and two-sided printing.

In the method of embossing points it is very important to make the points as high as possible, but without making holes in the tops of points.

One of the latest technologies is copying on microcapsule paper (figure 5)

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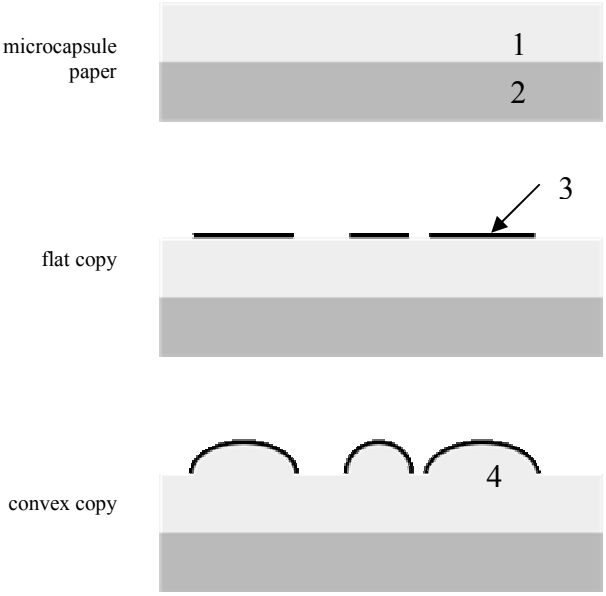

Figure 5: Phases of making a convex copy on microcapsule paper (1 – layer of microcapsules, 2 – ground, 3 – flat layer of dye; 4 – microcapsules after swelling)

This paper consists of base paper (1) and an applied layer of microcapsules (2). The first step of copying is preparing a greyscaled flat copy (3) (e.g. on a standard laser monochromatic printer). The next step is heating this copy (in the process of emitting light) in a special heater. In dark places, which absorb more energy, an over eighty time capacity enlargement of microcapsules can be observed (4). The surface in unprinted places remains unchanged. Printouts made in this technology have considerable durability. An additional advantage of this method is the ability of creating any embossed graphic (a blind person's touch resolution is the only limitation).

This technology is used often in making convex maps for blind and weak-sighted people. In the picture below (figure 6) the biggest Polish rivers are shown as convex lines. Such maps are sometimes in colour, which helps weak-sighted people to recognize another areas. The maps are very helpful not only as didactic help at schools, but they also help moving in foreign terrain.

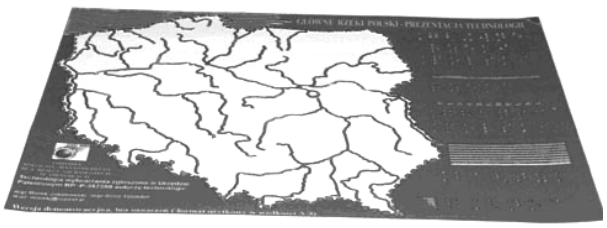

Figure 6: A convex map for blind and weak-sighted people.

A most recent method of making convex copies (in the final phase of development at the moment) is based on inkjet printing [1]. Both the printer and the sprayed ink are especially designed for this technology. Weather it will be widely used depends on the cost of the production of the devices.

Convex printouts in high edition are made with the technology of thermal foil forming. In this method it is necessary to make a matrix. The foil is formed on this matrix in a thermoform device.

Other methods [3] of making convex copies are seldom used.

Measurements

The non-contact optic methods are the best methods to measure quality parameters. The most useful one is the fringe projection method, which allows for 3D scanning of an item, and describing its surface by a cloud of points.

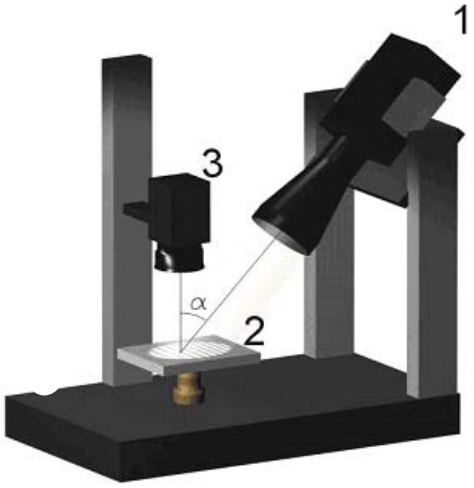

Figure 7: Measurement stand (1- fringe projector, 2 – rotation table, 3- CCD camera)

While scanning fringes are projected on the measured object and they change systematically from dark to bright according to Gray's code. (figure 8) Such a projection is made at several angles.

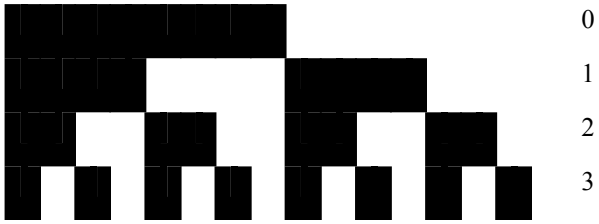

Figure 8: Sequence of fringes (Gray's code)

In areas where the height is changed, the view of fringes is deformed (Fig. 9). The software determines

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the cloud of points analysing the sequence of views. (Fig. 10)

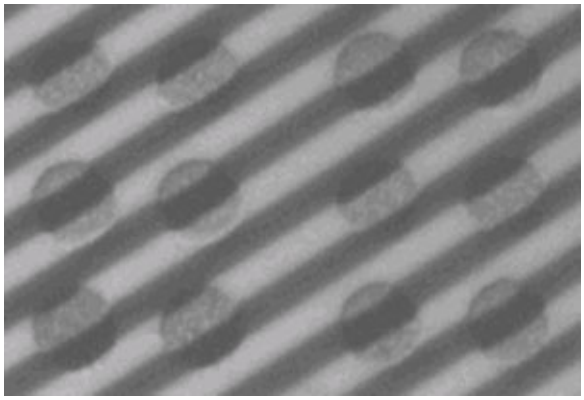

Figure 9: Measured sample in the process of scanning

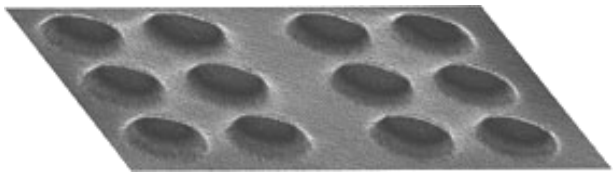

Figure 10: Cloud of points of the measured sample

The next stage of measuring is the analysis of the received cloud of points using different software, which contains algorithms for estimating each parameter.

Measurements were made on the fringe-projection stand in the Optical Engineering Division of the Institute of Micromechanics and Photonics of the Warsaw University of Technology.

Results

Research of quality parameters of convex copies for the blind is conducted in the Institute of Micromechanics and Photonics at the Warsaw University of Technology. The first step of each test is preparing a few copies of a special convex page in the same conditions and with the same printing parameters. Then in the following steps each copy is differentiated by:

- using a different technology
- using the same technology, but in devices of varied origin
- using the same device, with the same parameters, but on paper of varied origin
- introducing points of different size, or points have different another parameters

The printouts are scanned on the fringe – projection stand, and the resulting cloud of points is analyzed and the quality parameters are estimated.

The printouts are also judged by blind people. They compare each printout, or fragment of text and estimate which one is better for tactile reading.

The comparison of opinions of blind people and values of measurable quality parameters, makes it possible to estimate which parameters are most important in tactile reading, and therefore the values of the parameters can be established.

Conclusions

The height of the point is the most important quality parameter of convex copies. This parameter decides whether tactile recognition of the text is possible. The minimum height of points in these studies was estimated on 0,3mm [2].

The parameter R_B describes both roughness of the surface and the deviation of its shape. These studies show, that roughness should be possibly low.

Research on the quality of convex copies is still conducted and it leads to the estimation of universal, measurable quality parameters.

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